Water Quality in the North Fork of the Sugar Creek Watershed, Northeastern Ohio

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Abstract

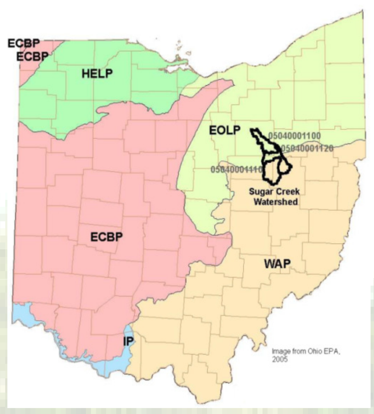
The Sugar Creek Watershed, identified by the Ohio Environmental Protection Agency in 1998 as one of the most degraded in the state, is a predominately agricultural watershed located in northeastern Ohio. One subwatershed of the Sugar Creek, the North Fork, attained its aquatic life use designation at two of three sites in 1998, but was impacted by sedimentation, nutrient enrichment, and habitat modification. Agricultural activities were implicated as a major reason for this impairment, specifically dairy farming. Starting in June 2002, bi-weekly water quality samples were collected at ten sites within the North Fork subwatershed through November 2007 to determine long term trends in water quality and evaluate the effects of best management practices. Reactive phosphorous was measured in the laboratory using a spectrophotometer, while total solids were determined using the gravimetric method. Our objective was to examine if overall water quality within the subwatershed has changed from 2002 to 2007. Over the sampling period, reactive phosphorus concentrations have decreased at most sites. Sites that did not show a decrease generally had lower initial concentrations of reactive phosphorus than sites that decreased. Total solid concentrations peaked in 2003 and have decreased since then. Future research will examine relationships between land use and water quality in the North Fork of the Sugar Creek watershed.

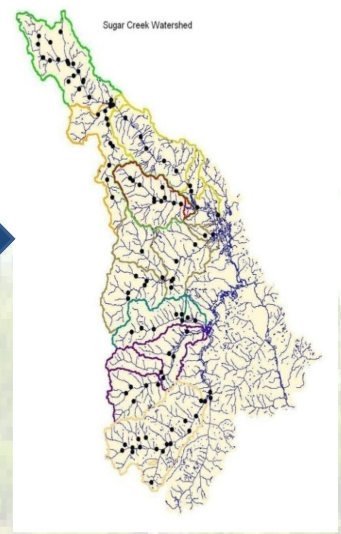
Introduction

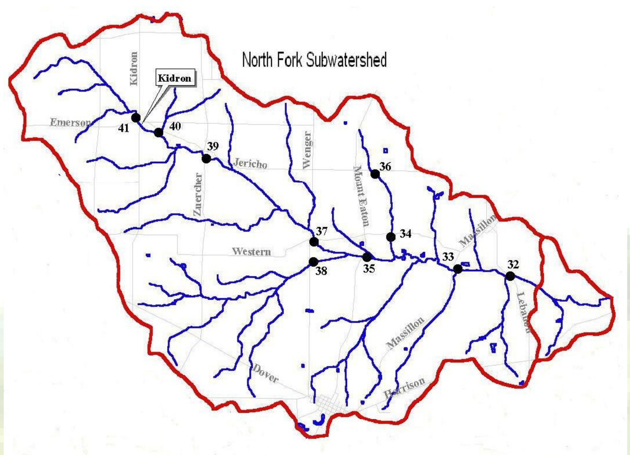
The Sugar Creek watershed is a mostly agricultural watershed located in northeastern Ohio. It drains 356.2 mi^2 and lies within the Muskingum River drainage basin, which drains to the Ohio River. In 1998, 93% of the Sugar Creek watershed did not meet Ohio EPA's aquatic life use standards (Ohio EPA, 2000).

One subwatershed of the Sugar Creek, the North Fork, is found in Wayne County, Ohio. Crop and dairy farming are common land use within this county. The North Fork drains 17.62 mi^2. It had some of the highest nutrient concentrations in the watershed in 1998, yet was able to attain aquatic life use standards at two of three sites (Ohio EPA, 2000). This area has a significant Amish and Mennonite population.

Since 1998, the community within the North Fork has taken actions aimed at improving water quality. Farmers have adopted best management practices and the Village of Kidron installed a wastewater treatment plant, which began discharging in 2004, to replace inadequate septic systems. We tested the hypothesis that water quality had improved over the sampling period. **Our objective was to examine if overall water quality within the subwatershed has changed from 2002 to 2007.**







Methods

Bi-weekly water quality samples were collected at ten sites within the North Fork June 2002 - November 2007. Reactive phosphorous was measured in the laboratory using a spectrophotometer. The gravimetric method was used to evaluate total solids. We tested for differences in annual mean solids and reactive phosphorus concentrations using Kruskal-Wallis tests with year as a factor (SYSTAT 12 software). Data with significant differences among years were further examined by comparing pairs of years with Mann-Whitney tests (SYSTAT 12 software).

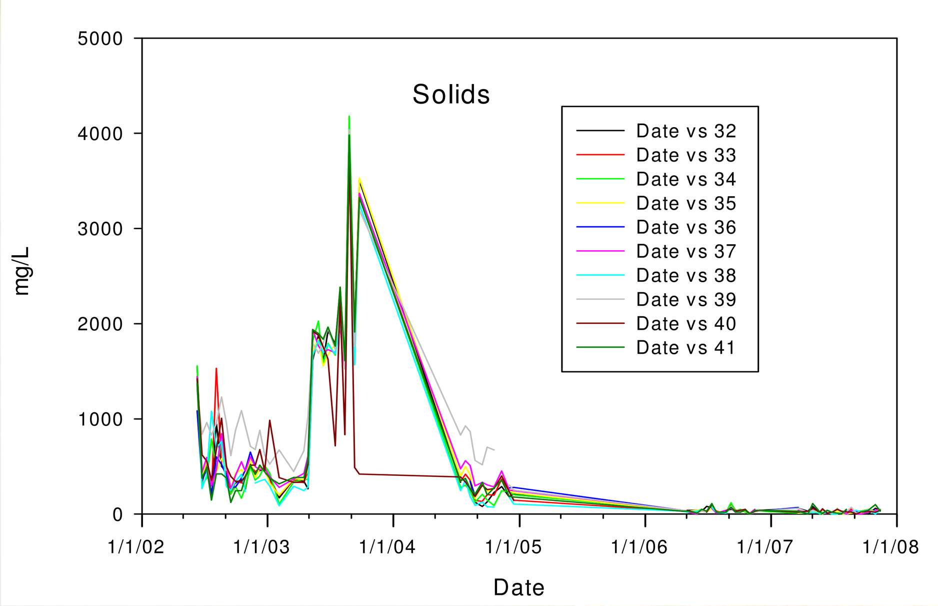
Results

Solids

All sites had significant differences in solids concentration among years ($p < 0.001$ for all sites, Kruskal-Wallis test). All sites except sites 36 and 40 had significantly greater solids concentrations in 2003 than in 2002. All sites except 36 had significantly smaller concentrations in 2004 than in 2003. All sites except 37 had significantly smaller concentrations in 2004 than in 2002. All sites had significantly smaller concentrations in 2006 and 2007 than 2004 (Mann-Whitney test).

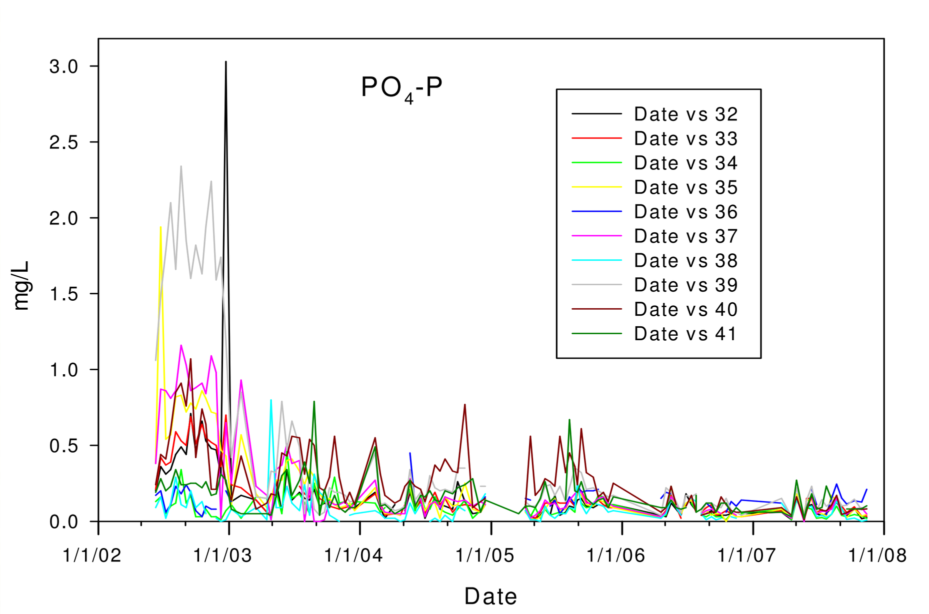
P-values of Solids Concentrations for Year by Year Comparisons

	32	33	34	35	36	37	38	39	40	41
02 v.03	0.021	0.045	0.006	0.026	0.525	0.015	0.04	0.03	0.101	0.002
02 v. 04	0.001	0.004	0.001	0.011	0.023	0.052	0.001	0.01	<.001	0.017
02 v. 06	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
02 v. 07	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
03 v. 04	0.001	0.002	<.001	0.003	0.053	0.002	0.001	0.01	<.001	< .001
03 v. 06	<.001	<.001	<.001	<.001	0.03	<.001	<.001	<.001	<.001	<.001
03 v.07	<.001	<.001	<.001	<.001	0.023	<.001	<.001	<.001	<.001	<.001
04 v. 06	<.001	<.001	<.001	<.001	0.002	<.001	<.001	<.001	<.001	<.001
04 v. 07	<.001	<.001	<.001	<.001	0.001	<.001	<.001	<.001	<.001	<.001
06 v. 07	0.066	0.388	0.423	0.005	0.543	0.091	0.068	0.77	0.219	0.581



P-values of Reactive Phosphorous Concentrations

	32	33	34	35	37	39	40	41
02 v.03	<.001	<.001	0.08	<.001	<.001	<.001	0.007	0.017
02 v. 04	<.001	<.001	0.513	<.001	<.001	<.001	0.002	0.003
02 v. 05	<.001	<.001	0.821	<.001	<.001	<.001	0.008	<.001
02 v. 06	<.001	<.001	0.232	<.001	<.001	<.001	<.001	<.001
02 v. 07	<.001	<.001	0.074	<.001	<.001	<.001	<.001	<.001
03 v. 04	0.185	0.088	0.099	0.003	0.27	0.578	0.657	0.433
03 v. 05	0.035	0.139	0.03	0.002	0.28	0.635	0.807	0.515
03 v. 06	0.001	0.001	0.002	<.001	0.04	0.006	<.001	0.336
03 v.07	0.002	0.004	<.001	<.001	0.03	0.01	<.001	0.31
04 v. 05	0.41	0.746	0.703	0.895	0.77	0.965	0.482	0.811
04 v. 06	0.018	0.037	0.008	0.017	0.04	0.003	<.001	0.004
04 v. 07	0.048	0.094	0.005	0.168	0.05	0.013	<.001	0.037
05 v. 06	0.137	0.016	0.034	0.028	0.01	0.001	<.001	0.001
05 v. 07	0.206	0.056	0.006	0.225	0.02	0.002	<.001	0.019
06 v. 07	0.689	0.755	0.473	0.318	0.87	0.787	0.849	0.936



Reactive Phosphorous

All sites except 36 and 38 had significant differences in reactive phosphorus concentrations among years ($p < 0.001$ for sites with a difference, Kruskal-Wallis test). For those sites with differences among years, concentrations were significantly higher in 2004 than 2006. 2002 had significantly higher concentrations than all other years for sites 32, 33, 35, 37, 39, 40, and 41. 2003 had significantly higher concentrations than 2006 and 2007 for sites 32, 33, 34, 35, 37, 39, and 40. 2004 had significantly higher concentrations than 2007 for 32, 34, 37, 39, 40, and 41 (Mann-Whitney test)..

Conclusions

Solids concentrations were lower at the end of the sampling period than at the peak in 2003, and seven sites had lower reactive phosphorous concentrations at the end of the sampling period than the beginning in 2002. The decrease in solid and reactive phosphorous concentrations provides evidence that management actions may have positively affected water quality with regards to these parameters. Landuse analyses may help explain reasons for these trends.

References

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